

A NEW SPECIES OF FROG OF THE  
*ELEUTHERODACTYLUS LACRIMOSUS* ASSEMBLY  
FROM AMAZONIA, SOUTH AMERICA  
(AMPHIBIA: ANURA: LEPTODACTYLIDAE)

W. Ronald Heyer and Laura M. Hardy

*Abstract.*—*Eleutherodactylus zimmermanae*, new species, is described from the Amazon Basin of South America. Because of the biological and nomenclatural complexity of frogs of the *Eleutherodactylus lacrimosus* assembly, a neotype is designated for *Cyclocephalus lacrimosus* Jiménez de la Espada, 1875.

Barbara Zimmerman has studied the ecology of frogs as part of the Biological Dynamics of Forest Fragments Project initiated by the Instituto Nacional de Pesquisas da Amazônia (INPA) and the World Wildlife Fund (WWF). This project was originally named the Minimum Critical Size of Ecosystems Project and is now co-administered by the Smithsonian Institution's (SI) National Museum of Natural History. Zimmerman has been involved with research on frogs at the study sites north of Manaus, Amazonas, Brazil, since almost the inception of the project some ten years ago (for further information, see Zimmerman & Rodrigues 1990). Zimmerman has collected three species of *Eleutherodactylus* from the INPA-WWF-SI research sites. She has identified one of these as *E. fenestratus*, but was unable to identify the other two and referred to them as species "1" and "2" (Zimmerman & Rodrigues 1990). Material of the *Eleutherodactylus fenestratus-gutturalis* complex from the INPA-WWF-SI sites seems to represent a single species that embraces the throat patterns used to distinguish *gutturalis* from *fenestratus* (Hoogmoed et al. 1977). Further study of all available materials of this complex is required to determine which name properly applies to the species at the INPA-WWF-SI sites. The species Zimmerman referred to as "2" (Zimmerman & Rodrigues 1990)

we identify as *Eleutherodactylus ockendeni*. The species she referred to as "1" is a new species allied to what Lynch & Schwartz (1971) and Lynch (1980) called *Eleutherodactylus lacrimosus*, which we describe as:

*Eleutherodactylus zimmermanae*,  
new species  
Figs. 1, 2, 3

*Holotype.*—MZUSP 64539, adult male from Brazil: Amazonas, Reservas INPA-WWF-SI, approximately 80 km N of Manaus, approximately 2°20'S, 59°50'W. Collected by Barbara Zimmerman, 7 Dec 1984.

*Paratopotypes.*—INPA 1371, MZUSP 64535-38, 64540-41, USNM 304278-304279, collected by Barbara Zimmerman on 7 Dec 1984 (MZUSP 64535-38) and 17 Mar 1987 (remainder of paratopotypes).

*Methodological note.*—The morphological terminologies and definitions used herein follow those detailed in Heyer et al. (1990) in general and Savage (1987) for finger and toe tips.

*Diagnostic definition* (scheme established by Lynch, e.g., 1979, of numbered character states followed here for ease of comparison).—(1) Skin of upper surfaces generally smooth, that of venter coarsely areolate; (2) tympanum distinct, its horizontal diameter about 1/3 eye diameter; (3) snout subelliptical with pointed tip in dorsal view, acute in



Fig. 1. Specimens photographed in life by Walter Hödl from Reserva Ducke, Amazonas, Brazil. Above, single male NMW 32112:1, below, amplexant pair NMW 32112:2-3.



Fig. 2. Dorsal view of holotype of *Eleutherodactylus zimmermanae*, MZUSP 64539, adult male.

profile; canthus rostralis sharply rounded; (4) upper eyelid width slightly smaller than interocular distance, with several well defined tubercles; no cranial crests; (5) no vomerine teeth; (6) males with vocal slits and single subgular vocal sac expanded and wrinkled in preservation; no nuptial asperities on thumb; (7) first finger just shorter than second; fingers bearing large disks (largest on III and IV); disks broader than long; (8) fingers with weakly to well-developed lateral keels; (9) row of two to five distinct ulnar tubercles; (10) row of three to four fleshy tubercles on inner tarsus, but no fold (usually); heel smooth to granular; (11) two metatarsal tubercles, inner oval, two to three times size of outer; a few scattered fleshy plantar tubercles; (12) toes bearing

weakly to well-developed lateral keels; no webbing; toe disks about same size as those of outer fingers; (13) predominantly brown frog, no flash colors; posterior surface of thighs brown; (14) adults small, males 19.1–21.2 mm, females 22.4–25.8 mm SVL.

Throughout most of its range, *E. zimmermanae* occurs with *E. fenestratus* and *E. ockendeni*. *Eleutherodactylus fenestratus* has a smooth belly; the belly is areolate in *E. zimmermanae*. *Eleutherodactylus ockendeni* lacks ulnar and tarsal tubercles and usually has distinct dark suborbital bars; *E. zimmermanae* has ulnar and tarsal tubercles and suborbital bars, if present, are faint. See Discussion for additional diagnostic comparisons.

*Description of holotype.*—Snout shape

subelliptical and pointed at tip in dorsal outline, acute in profile; canthus rostralis sharply rounded; lip barely flared; upper eyelid width slightly less than interocular distance; no external indications of cranial crests; tympanum hidden by supratympanic fold dorsally, distinct and somewhat flared below, small, horizontal diameter about  $\frac{1}{3}$  eye diameter; no vomerine teeth; choanae small, bean-shaped, separated by distance three to four times diameter of single choana; vocal slits present, elongate; vocal sac single, distended, extending to chest region; finger lengths I just  $<$  II  $<$  IV  $<$  III; finger disks present, smallest on thumb ovoid, Finger II disk also ovoid but larger, disks on Fingers III and IV largest, broadened, upper surfaces not indented or notched, largest disk about same size as tympanum; fingers with weak lateral keels; finger webbing absent; single fleshy tubercle on outer edge of hand nearer finger than base of palm; palmar tubercle large, bifid, about twice size of ovate thenar tubercle, supernumerary palmar tubercles not obvious; subarticular tubercles distinct, rounded, single; nuptial excrescences absent; outer ulnar region with row of three pale rounded fleshy tubercles; supratympanic fold weakly developed; other glands or folds on top or sides of body absent; upper eyelid with several tubercles, rest of dorsum smooth except scattered, weakly developed tubercles on dorsal surface of shank; throat smooth, vocal sac wrinkled; fold distinct between chest and belly; posterior chest and entire belly areolate-granular; ventro-posterior surfaces of thighs weakly granular; ventral limb surfaces smooth; toe lengths I  $<$  II  $<$  III  $<$  V  $<$  IV; disk on Toe I very small, barely broader than toe; disks on Toes II and III ovoid and increasingly larger; disks on Toes IV and V large, broadened, largest toe disks slightly larger than largest finger disks; sides of toes with weak keels; barest rudiment of webbing between Toes IV–V, otherwise webbing absent; outer round metatarsal tubercle about  $\frac{1}{3}$  size of ovate inner metatarsal

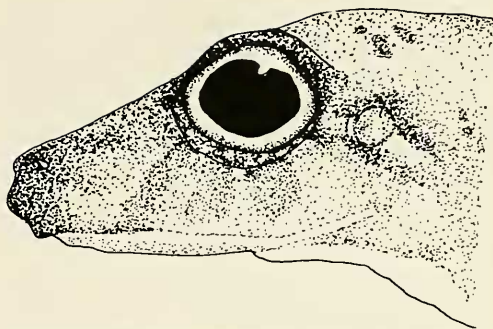


Fig. 3. Side of head of holotype of *Eleutherodactylus zimmermanae*.

tubercle; series of three relatively evenly spaced, rounded, fleshy tubercles along tarsus (but no fold); remainder of outer tarsal region smooth; heel smooth; plantar surface with a few scattered indistinct rounded fleshy tubercles; subarticular tubercles distinct, rounded.

Coloration in alcohol: Tip of snout, incomplete canthal stripe, distinct interorbital bar, and supratympanic fold dark brown; tympanum and side of head weakly mottled with brown and tan, faint suborbital bars; area in front of interorbital bar pale tan with indistinct small brown flecks; dorsum with faint brown W in scapular region; remainder of back with broken dark stripes and two transverse series of dots between sacrum and vent; otherwise dorsum with relatively densely scattered melanophores; flanks with series of oblique incomplete dark brown stripes; upper surfaces of limbs with dark wrist stripes and remainder of upper limbs, except for shanks, with darker brown transverse bars on a lighter brown background, cross bars incomplete on upper surfaces of shanks; ventral surfaces of limbs with scattered melanophores; unpigmented on posteriormost part of belly and on upper thighs; posterior surfaces of thighs with scattered, evenly distributed brown melanophores.

*Measurements of holotype.*—SVL 19.1 mm, head length 7.2 mm, head width 6.9 mm, horizontal tympanum diameter (in-

cluding annulus) 0.9 mm, thigh 8.4 mm, shank 9.5 mm, foot 8.0 mm.

*Variation.*—Only features that extend the variation beyond that given for the holotype are presented.

SVL for other males examined ( $n = 12$ ) 19.6–21.6 mm SVL, females ( $n = 6$ ) 22.3–25.8 mm SVL; head length 37–40% SVL (males and females); head width 33–38% SVL (males), 38–40% SVL (females); tympanum horizontal diameter 4–6% SVL (males and females); thigh length 42–48% SVL (males and females); shank length 46–51% SVL (males and females); foot length 41–45% SVL (males and females).

Dorsal outline of snout subelliptical or subovoid, usually strongly pointed at tip, weakly pointed at tip in one individual; snout profile rarely weakly acute; choanal shape sometimes ovate; first finger rarely about same length as second; disks on Fingers I and II sometimes ovoid-broadened, sometimes broadened on II, disk on III with barest dorsal medial indentation in one individual, largest disks rarely larger than tympanum; finger edges sometimes distinctly keeled; short dermal fold on edge of hand continuous or not with outer finger ridge, sometimes reduced to single elongate to rounded fleshy tubercle; palmar tubercle ranging in size to about same as thenar tubercle, palmar tubercle usually deeply bifid; four prominent to indistinct fleshy round supernumerary palmar tubercles; from two to five (usually four) fleshy tubercles on outer ulnus (sometimes only indicated by light spots apparently due to preservation artifact); dorsum in some with scattered, weakly developed tubercles, dorsal tubercles much less obvious than eyelid tubercles; upper flanks sometimes with scattered tubercles or entire flanks sometimes weakly granular; dorsal tubercles on shank indistinct in some specimens; discoidal fold at anterior belly well developed to absent; belly in some specimens irregularly areolate; disk on Toe I usually noticeably broader than toe, ovoid,

disk on Toe III also ovoid-broadened to broadened; largest toe disks also same size as or slightly smaller than largest finger disks; toes in some specimens with distinct lateral keels; no vestige of toe webbing in some specimens; outer metatarsal tubercles ranging in size from  $\frac{1}{3}$  to almost  $\frac{1}{2}$  size of inner; some individuals with row of four fleshy tubercles on outer tarsus (tubercles in some only discernible by light spots apparently due to preservation artifact), in two specimens a tarsal fold evident with two to three weak to prominent tubercles on it; two to three other fleshy tubercles scattered on outer tarsal surface (smaller than tubercles in tarsal fold zone) in some specimens; heel sometimes granular or with two to three low fleshy tubercles; in addition to fleshy tubercles, plantar surfaces granular in some specimens; two small, light, fleshy, tubercles in metatarsal fold region near toe in some specimens, such tubercles, if present, always smaller than outer hand tubercles on any given specimen; in one individual, three additional less distinct tubercles in proximal metatarsal fold area, but not on same line with two tubercles in distal metatarsal fold area.

Tip of snout not darker than surrounding pattern in some specimens; canthal stripe ranging from well defined to absent, but usually apparent; side of head uniform brown in some individuals; interorbital bar narrow, or interrupted, or abutting light bar anteriorly in some individuals; snout anterior to interorbital bar ranging from noticeably lighter to same intensity as dorsal ground color; dorsal pattern variable, including broad scapular chevron continuous with dark interorbital triangle extending posteriorly from interorbital bar, vaguely defined broad sacral chevron, dark transverse band anterior to vent, broad scapular W-shaped mark more distinct than described for holotype in some specimens, two broad but ill-defined lighter dorsolateral bands from eyes to mid-flanks in some in-

dividuals, or dorsum almost uniform with two lines of dots behind eyes in others; upper surfaces of limbs sometimes indistinctly striped to almost uniform tan; oblique stripes on flanks sometimes barely defined to an indistinct scattering of darker brown dots on a brown ground color; posterior surfaces of thighs sometimes uniform brown or with lighter areas distally.

WCAB 2315 from Serra do Navio, Amapá, Brazil, is somewhat distinctive in having well-developed tarsal folds with three swellings (in same places as tubercles in other specimens). The ulnar tubercles are the same as in other specimens.

Three specimens from Colombia (KU 153286–153288) differ from other specimens in that the ulnar and tarsal tubercles are ill-defined at best and the dark dorsal markings are sharply defined. These specimens should be re-evaluated in any further taxonomic considerations dealing with Colombian members of the *lacrimosus* assembly.

*Color in life.*—Type specimens collected 17 Mar 1987: “Iris copper with darker reddish streak running across eye horizontally. Irises of two specimens are more reddish brown than copper. Copperish sheen on back and snout. Dorsal colouration varies among the three individuals. Two individuals have distinct interorbital yellow line that divides a reddish snout from darker brown dorsum. All three specimens have unmarked yellow throats and venters. All three have some dark markings on back but form of markings varies” (B. L. Zimmerman field notes, pers. comm.).

Rondônia specimens: “Dorsum light brown. Triangle of darker brown from eyes and extending to middle of back. Triangle outlined with lighter yellow-brown line. Venter lighter yellow-brown. Stripes of black on chest and chin. Eye yellow brown with light orange stripe. Black reticulations in eye [MZUSP 61551]. Dorsum patterned with tan and brown. Light tan triangular area

from snout to between eyes. Eyes pale bronze with reddish streak [MZUSP 61553]. Yellow thighs [MZUSP 61554]. Pale salmon-colored thighs [MZUSP 61555]” (J. P. Caldwell field notes, pers. comm.). “Medium brown above with darker, vague scapular W. Dark interorbital line; snout anterior to it pale tan. Eyelids and postocular stripes slightly darker tan. Entire venter dull yellow but throat bright lemon yellow. Concealed thighs dull orange-yellow. Iris brassy [USNM 304166]” (R. I. Crombie field notes, pers. comm.).

*Advertisement call.*—Call a sharp “té” chirp; no call groups (based on analyses of 50 sec segments at beginning, middle, and end of 306 sec tape); based on loudest calls, maximum call rate 1.03 calls/sec; call duration about 0.05 sec (exact duration undeterminable due to background calls blending with loudest calls); one markedly to weakly pulsatile note/call, about 18 pulses/call given at a rate of 340 pulses/sec; call moderately intensity modulated, first half of call louder than second; call markedly frequency modulated, starting at lowest frequency of call and rising quickly to highest frequency; average (of 33 calls) frequency sweep 3485–4222 Hz; frequency shift in maximal energy of call from beginning to end of tape 4000 to 3500 Hz; dominant frequency same as fundamental; no harmonic structure evident in call (Fig. 4).

*Etymology.*—Named for Barbara Zimmerman in recognition of her contributions toward an understanding of Amazonian frogs.

*Ecological notes.*—“A widespread and commonly heard species throughout the forest. Calls exclusively nocturnally from 1.5–2.5 meters high especially in shrubby, tangled, or treefall type of vegetation. Generally 1 to 5 males call in a group. They call more in the wetter months, mostly from November until May. During the month of peak calling activity, the average abundance of calling males is eleven per km [of trail],

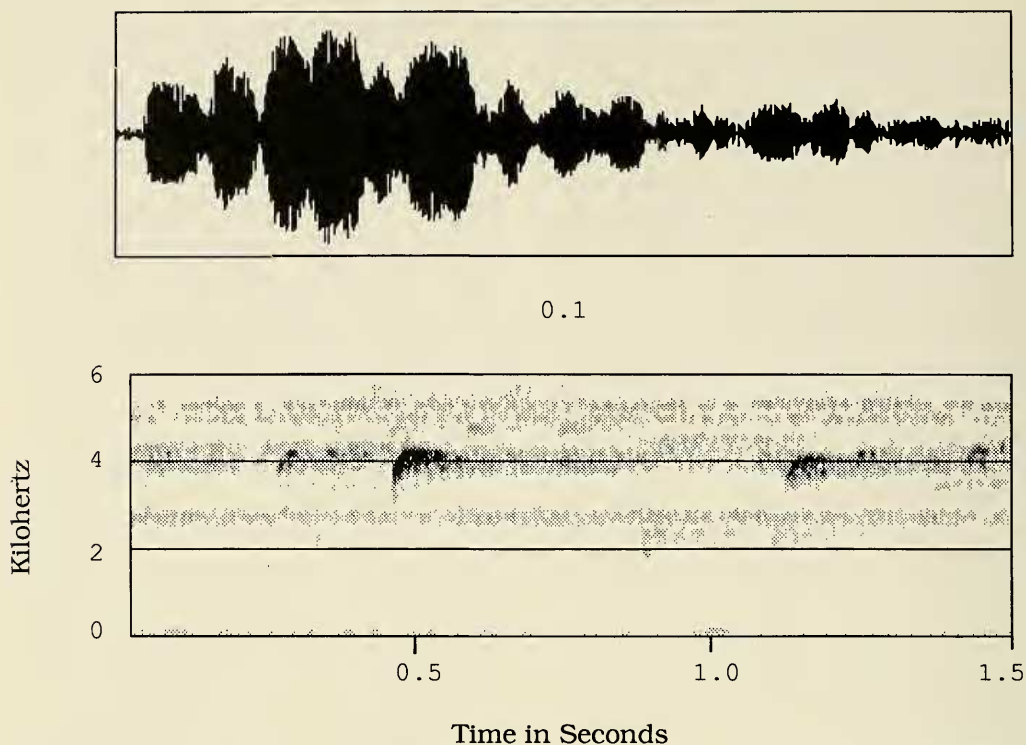


Fig. 4. Wave form and audiospectrogram of advertisement call of *Eleutherodactylus zimmermanae*. From recording USNM tape 154, cut 2, recorded by B. L. Zimmerman on 07 December 1984, 2012 h.

falling to less than one caller per km during the driest month. They are extremely hard to find although the call is clearly heard” (B. L. Zimmerman notes from INPA-WWF-SI sites, pers. comm.).

Walter Hödl collected a pair in amplexus (Fig. 1, below) at the Reserva Ducke, Amazonas (NMW 32112:2–3) at 2115 h on 10 Mar 1990 on a leaf of a bush at a height of 1.7 m. From the same locality, he recorded and collected a calling male (NMW 32112: 1) (Fig. 1, above) at 2050 h on 13 Mar 1990 on a tree at a height of about 2 m during a slight rain.

Janalee P. Caldwell recorded the following information on a series collected from Santa Cruz da Serra, Rondônia: (a) in rolled up leaf of plant (3') in forest during day, 15 May 1985 (MZUSP 61550); (b) from relatively undisturbed forest, in center of banana plant after all leaves removed, wedged

in axil of last leaf, 1400 h, 15 May 1985 (MZUSP 61551); (c) from a bromeliad on a fallen tree, about 1200 h, 6 Jun 1985 (MZUSP 61552); (d) on a bromeliad on a fallen log near a drying pond at night, 2 Sep 1985 (MZUSP 61553); (e) in a large bromeliad in a log in a pond by the road, about 1600 h, 7 Sep 1985 (MZUSP 61554–61555).

Ronald I. Crombie captured two calling males, one from Alto Paraiso, Rondônia (USNM 304166), 3 m up on a stem of a small tree in degraded forest at night on 29 Oct 1985, and one from Santa Cruz da Serra (USNM 304167) on a leaf 2.5 m up on a small tree in good forest at night on 6 Nov 1985. (See Vanzolini, 1986, for discussion of Rondônia localities.)

*Referred specimens.*—BRAZIL. ACRE: Estrada Rio Branco-Abunã, 90 km from Rio Branco, MZUSP 6532. AMAPÁ: Serra do Navio, WCAB 2315. AMAZONAS: Reser-



Fig. 5. Northern South America known distribution of *Eleutherodactylus zimmermanae*. Square = type locality. Dots = other localities.

va Ducke, MZUSP 50164, NMW 32112:1–3. RONDÔNIA: Alto Paraiso, USNM 304166; Santa Cruz da Serra, MZUSP 61550–61555, USNM 304167.

COLOMBIA. AMAZONAS: Petuna, Río Loreto-yacu, KU 153286–153288.

Note: We specifically restrict the types to the specimens collected from the type locality.

*Distribution.*—Known from a few scattered localities in the Amazon Basin (Fig. 5).

As far as is known, *E. lacrimosus* occurs only on the eastern Andean slope region of Ecuador. We have examined the Brazilian and Colombian specimens identified by Lynch & Schwartz (1971) as *E. lacrimosus*. Our opinions about these specimens are the following. WCAB 2315 from Serra do Navio, Brazil is *E. zimmermanae*. KU 127318

from near Belém, Brazil appears to represent a different (probably new) species of the *lacrimosus* assembly. Although the specimen is somewhat desiccated, a distinct rudimentary web between Toes IV and V distinguishes this specimen from both *E. lacrimosus* and *E. zimmermanae*. KU 110410 from Isla la Vieja, Caquetá, Colombia, also is neither *E. lacrimosus* nor *E. zimmermanae*; it has vomerine teeth and a distinct tarsal fold bearing two to three tubercular projections. Of the described members of the *lacrimosus* assembly, this specimen seems to be closest to *E. petersi* (but see the comment on *E. petersi* in the following discussion).

#### Discussion

*Eleutherodactylus zimmermanae* is a member of the *E. lacrimosus* assembly of



the *E. unistrigatus* group as defined by Lynch & Duellman (1980). The *lacrimosus* assembly as used by Lynch applied herein is a phenetic subgroup within the large *E. unistrigatus* species group. Lynch & Ruíz-Carranza (1985) indicated that the species belonging to the *lacrimosus* assembly were: *boulengeri*, *brevifrons*, *bromeliaceus*, *eremitus*, *lacrimosus*, *mendax*, *petersi*, *phoxocephalus*, *prolixodiscus*, and *tayrona*. Subsequently, Rivero & Serna (1987) added *E. dorsopictus* and Duellman (1990) added *E. schultei* to the assembly. Lynch (pers. comm.) suggested that *E. apiculatus* Lynch & Burrowes (1990) is part of this assembly, but based on our reading of the description, *E. apiculatus* seems quite distinct from other assembly members. It should be pointed out that Lynch (in litt., 9 Jan 1991) views his "*lacrimosus* assembly as a phenetic unit rather than a taxonomic one" perhaps representing "consequences of life between the axils of bromelias." The nomenclature of *E. lacrimosus* and the variation in systematic characters separating these taxa preclude a straightforward comparison and distinction of *E. zimmermanae* from the other members of the assembly.

*Cyclocephalus lacrimosus* Jiménez de la Espada (1875) is based on an illustration of the dorsal view and line drawings of the pectoral girdle and open mouth (Plate 3 bis, figures 5, 5a, 5b); no description accompanied the drawings. William E. Duellman did not find the type in the Madrid collection during a search for Jiménez de la Espada types (Lynch & Schwartz 1971:107). Frost (1985:298) gave the type status as "Lost." We asked the curator at the Museo Nacional de Ciencias Naturales, Madrid, whether the type had been located since Duellman had examined the collection. In spite of further searching efforts, the type has not been found (José Enrique González Fernández, in litt., 24 Oct 1990). Most of the collection that included the type of *Cyclocephalus lacrimosus* perished after reach-

ing Spain (Savage 1978:xii); all evidence indicates that the type of *Cyclocephalus lacrimosus* has been lost or destroyed.

Lynch & Schwartz (1971) concluded that Espada's figures were sufficient to associate the name with museum specimens of (what they considered to be) a rather wide-ranging Amazonian species of *Eleutherodactylus*, for which they provided a new diagnosis, description, and figure of the dorsum. Lynch & Schwartz (1971:110) interpreted nine features from the figures: "(1) skin of dorsum finely shagreened; (2) digits bearing small digital pads; (3) digits free of webbing; (4) first finger nearly as long as second; (5) prevomerine dentigerous processes present, sharply inclined; (6) omosternum small; (7) posterior surface of thigh unicolor; (8) color pattern simple; and (9) outline of head in form of half circle." We do not find the figure copies available to us adequate to determine whether the dorsal texture is smooth or finely shagreened. Only one hand is figured; because of the perspective, the first finger could be considerably shorter than the second. The outline of the head of the type figures is indeed a half circle with no indication of a pointed snout tip (papilla) characteristic of members of the *E. lacrimosus* assembly. In 1971, Lynch & Schwartz thought there was a single species in what is now an assembly of eleven species. We believe that there is not enough information extractable from Jiménez de la Espada's figures to associate absolutely his *lacrimosus* with only one of the species within the *E. lacrimosus* assembly.

The species that Lynch & Schwartz re-described and figured as *lacrimosus* is the most distinctive species within the assembly; it has smooth upper eyelids and lacks series of ulnar and tarsal tubercles, all features found to varying degrees in the other members of the assembly. Because Lynch & Schwartz's (1971) redescription has been used by all subsequent workers to define *E. lacrimosus* and because there is sufficient

doubt (in the absence of a type) as to the exact allocation of Jiménez de la Espada's *Cyclocephalus lacrimosus*, we think the situation merits designation of a neotype to preclude further confusion. We have examined and hereby designate KU 110782, an adult female from Santa Cecilia, Napo, Ecuador, 340 m (the specimen figured by Lynch & Schwartz 1971: fig. 4), as the neotype of *Cyclocephalus lacrimosus*. The neotype conforms to the description provided by Lynch & Schwartz (1971) with the minor exceptions that the upper eyelids, although flattened in preservative, appear to be weakly tuberculate and moderately developed antibrachial tubercles are present. The neotype is from the region known to have been visited by Jiménez de la Espada (Savage 1978).

*Eleutherodactylus zimmermanae* occurs in the lowlands of Amazonia. All other known members of the *E. lacrimosus* assembly occur on moderate to high slopes of the Andes in Colombia, Ecuador, and Peru. However, the closely related *E. tubernasus* assembly occurs in Venezuela (Lynch & Ruíz-Carranza (1985). Preserved members of the *E. lacrimosus* assembly almost need to be compared side by side with each other to differentiate the species. In many instances, the development of tubercles and color patterns is distinctive, but it is difficult to express those differences adequately in words. Of the described species of the *E. lacrimosus* assembly, only *E. dorsopictus*, *E. mendax*, *E. zimmermanae*, and some individuals of *E. brevifrons* and *E. schultei* lack vomerine teeth. *Eleutherodactylus brevifrons* has pale green upper eyelids in life and is known from several localities in the high cloud forests of the Cordillera Occidental and the north part of the Cordillera Central of Colombia (J. D. Lynch, pers. comm.). *Eleutherodactylus mendax* from the Andean slopes of Amazonian Peru has smooth heels and a green dorsum in life. *Eleutherodactylus zimmermanae* does not

have a green dorsum in life and usually has granular or fleshy tuberculate heels. *Eleutherodactylus schultei*, from high elevation cloud forest in the northern part of the Cordillera Central, Department of Amazonas, Peru, lacks eyelid tubercles and is larger than *E. zimmermanae* (*E. schultei*—males 23.5–26.6 mm, females 28.4–34.0 mm SVL). *Eleutherodactylus dorsopictus* from the Páramo de Sonsón, Cordillera Central, Colombia, has divided subarticular tubercles on the hand; in *E. zimmermanae* the subarticular tubercles are single.

We are aware of at least two other new species in this assembly being worked on by others. Once variation in this assembly is better understood, more species will be recognized from specimens already in collections. For example, the paratypes of *E. petersi* in the USNM collections apparently represent two species in addition to *petersi*.

Most members of the *E. lacrimosus* assembly are associated with or at least often collected from bromeliads (Lynch & Schwartz 1971; Duellman 1978a, 1990; Lynch 1978, 1979, 1980, 1981; Lynch & Duellman 1980; Lynch & Ruíz-Carranza 1985; Rivero & Serna 1987), but *E. apiculatus* is not associated with bromeliads (Lynch & Burrowes 1990). *Eleutherodactylus zimmermanae* may demonstrate differential use of bromeliads depending on their abundance or season of the year. J. P. Caldwell found them in bromeliads in Rondônia, but R. I. Crombie did not. B. Zimmerman did not notice an association with bromeliads in the central Amazon Basin.

Calls have been noted for seven other species of the assembly (none of which have been recorded). The calls of *E. boulengeri*, *brevifrons*, *lacrimosus*, and *petersi* are described as single “peeps” (Duellman 1978b, Lynch & Duellman 1980, Lynch 1981), *E. phoxocephalus* as a single sharp whistle (Lynch 1979), *E. schultei* as “ping-ping” (Duellman 1990), and *E. apiculatus* as “peep-peep” (Lynch & Burrowes 1990).

Perhaps recordings of members of this assembly will help in establishing the boundaries of the species limits.

### Acknowledgments

Research for this paper was initiated while Laura M. Hardy was a Smithsonian Institution Natural History Summer Intern.

Barbara Zimmerman made her data from the INPA-WWF-SI research sites available to us. Janalee P. Caldwell, Ronald I. Crombie, and Walter Hödl also shared their field data with us. Werner C. A. Bokermann (WCAB), W. E. Duellman, University of Kansas Museum of Natural History (KU), F. Tiedemann, Naturhistorisches Museum Wien (NMW), and P. E. Vanzolini, Museu de Zoologia da Universidade de São Paulo (MZUSP) allowed us to examine specimens in their care. José Enrique González Fernández kindly searched the Museo Nacional de Ciencias Naturales collection for the type of *Cyclocephalus lacrimosus*. Ronald I. Crombie and John D. Lynch critically read drafts of this paper. Jennifer Westhoff drew the illustrations reproduced as Figs. 2 and 3. Walter Hödl allowed us to use his slides to produce Fig. 1.

Research leading to this paper was supported, in part, by the Museu de Zoologia da Universidade de São Paulo and the IESP Neotropical Lowland Research Program, Smithsonian Institution. Mr. Adam Zimmerman donated the funds for printing the color plate which enhances this paper.

### Literature Cited

- Duellman, W. E. 1978a. Three new species of *Eleutherodactylus* from Amazonian Perú (Amphibia: Anura: Leptodactylidae).—*Herpetologica* 34: 264–270.
- . 1978b. The biology of an equatorial herpetofauna in Amazonian Ecuador.—University of Kansas Museum of Natural History, Miscellaneous Publication 65:1–352.
- . 1990. A new species of *Eleutherodactylus* from the Andes of northern Peru (Anura: Leptodactylidae).—*Journal of Herpetology* 24:348–350.
- Frost, D. R. (ed.). 1985. Amphibian species of the world. Allen Press, Inc., and The Association of Systematic Collections, Lawrence, Kansas, 732 pp.
- Heyer, W. R., A. S. Rand, C. A. G. da Cruz, O. L. Peixoto, & C. E. Nelson. 1990. Frogs of Boracéia.—*Arquivos de Zoologia* 31:231–410.
- Hoogmoed, M. S., J. D. Lynch, & J. Lescure. 1977. A new species of *Eleutherodactylus* from Guiana (Leptodactylidae, Anura).—*Zoologische Mededlingen* 51:33–41.
- Jiménez de la Espada, M. 1875. Vertebrados del Viaje al Pacífico Verificado de 1862 a 1865 por una Comisión de Naturalistas enviada por el Gobierno Español. Batracios. Imprenta de Miguel Ginesta, Madrid, 208 pp.
- Lynch, J. D. 1978. A new eleutherodactyline frog from the Andes of northern Colombia (Leptodactylidae).—*Copeia* 1978:17–21.
- . 1979. Leptodactylid frogs of the genus *Eleutherodactylus* from the Andes of southern Ecuador.—University of Kansas Museum of Natural History, Miscellaneous Publication 66:1–62.
- . 1980. *Eleutherodactylus eremitus*, a new trans-Andean species of the *lacrimosus* assembly from Ecuador (Amphibia: Leptodactylidae).—*Museum of Comparative Zoology Breviora* 462: 1–7.
- . 1981. Two new species of *Eleutherodactylus* from western Colombia (Amphibia: Anura: Leptodactylidae).—*Occasional Papers of the Museum of Zoology, University of Michigan* 697:1–12.
- , & P. A. Burrowes. 1990. The frogs of the genus *Eleutherodactylus* (Family Leptodactylidae) at the La Planada Reserve in southwestern Colombia with descriptions of eight new species.—*Occasional Papers of the Museum of Natural History, University of Kansas* 136:1–31.
- , & W. E. Duellman. 1980. The *Eleutherodactylus* of the amazonian slopes of the Ecuadorian Andes (Anura: Leptodactylidae).—*University of Kansas Museum of Natural History, Miscellaneous Publication* 69:1–86.
- , & P. M. Ruiz-Carranza. 1985. A synopsis of the frogs of the genus *Eleutherodactylus* from the Sierra Nevada de Santa Marta, Colombia.—*Occasional Papers of the Museum of Zoology, University of Michigan* 711:1–59.
- , & A. Schwartz. 1971. Taxonomic disposition of some 19th Century leptodactylid frog names.—*Journal of Herpetology* 5:103–114.
- Rivero, J. A., & M. A. Serna. 1987. Tres nuevas especies de *Eleutherodactylus* (Amphibia, Leptodactylidae) de Antioquia, Colombia.—*Caribbean Journal of Science* 23:386–399.
- Savage, J. M. 1978. Marcos Jiménez de la Espada,

- naturalist explorer of the Andes and upper Amazon Basin. Pages vii–xvi in reprinted edition of *Vertebrados del Viaje al Pacifico*. Batracios.—Society for the Study of Amphibians and Reptiles.
- . 1987. Systematics and distribution of the Mexican and Central American rainfrogs of the *Eleutherodactylus gollmeri* group (Amphibia: Leptodactylidae).—*Fieldiana: Zoology*, New Series 33:1–57.
- Vanzolini, P. E. 1986. Levantamento herpetológico da área do estado de Rondônia sob a influência da rodovia BR 364.—Programa Polonoroeste, Relatório de Pesquisa 1:1–50.
- Zimmerman, B. L., & M. T. Rodrigues. 1990. The frogs, snakes, and lizards of the INPA-WWF reserves near Manaus in the central Amazon. Pp. 426–454 in A. Gentry, ed., *Four neotropical rainforests*. Yale University Press, New Haven.
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